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ABSTRACT

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THE SYLLABLE AS A SOURCE OF ERROR IN MULTISYLLABLE WORD RECOGNITION

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Benton J. Underwood and Joel Zimmerman

Northwestern University

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Abstract

Two-syllable words were presented singly for study followed by a two-alternative, forced-choice recognition test. Half of the new words on the test (I words) were constructed by combining two syllables taken from two different study words, and half were neutral words (C words). If, as a consequence of study, the memory for a word carries frequency information about each syllable of multisyllable words, the number of errors produced by choosing I words should be greater than the number produced by choosing C words. The results supported this expectation. Furthermore, differences which occurred during the test suggested that syllabic frequency was further increased during testing. Frequency induction to elements of larger units was proposed as the mechanism by which formal similarity influences recognition.

When the frequency information which is a part of the memory for words presented for learning is juxtaposed against recognition decisions on those words the resulting relationship strongly suggests that the frequency knowledge is critically involved in the recognition decisions (Underwood, 1972). To infer a causal relationship from such facts is not to assert that semantic, or meaning responses to the words are of no consequence for recognition. It is quite possible that the perceptual representational response to a word and the semantic responses are both represented, perhaps independently, in the frequency information about each word. In the present study the inquiry concerns the syllable as a unit in multisyllable words. Essentially, the question is whether recognition errors are predictable when it is assumed that the frequency of a syllable has representation in the memory for a word.

To propose that a syllable of a word has frequency representation in memory is to assume that the subject may abstract a smaller unit (syllable) from a larger unit (word) and that this smaller unit is given some degree of independence in memory. On the surface, such an assumption may seem preposterous. Yet, it is known that this type of abstraction has occurred in the developmental history of the subject. Subjects have a good knowledge of the frequency with which individual letters occur in words (Attneave, 1953). This knowledge could only arise by abstracting letter frequencies from larger units (words) since

it is unlikely that a subject experiences letters in isolation with frequencies that correspond to the frequencies with which the letters occur in words. Subjects also have a good knowledge of the relative frequencies with which words occur in printed discourse (e.g., Shapiro, 1969), and this could come about only by abstracting their frequencies from a broader context (sentences). Although less precise than frequency information about letters and words, the subject does carry reliable information about the frequencies of bigrams in words (Underwood, 1971).

The above evidence indicates that information about the frequencies of units appearing as parts of larger units has been assimilated over many years by the usual subject. However, it may be quite another matter to expect that the subject would abstract syllable frequencies from words in a single presentation of a list of words in the laboratory. Nevertheless, if this does occur it has a number of implications for the study of recognition. An elaboration of this point will be delayed to the discussion section.

The rationale of the experiment may now be examined. The subject was presented a list of two-syllable words singly for study. These words were chosen so that when a pair of words was considered, a new word could be formed by combining the first syllable of one of the words with the second syllable of the other. For example, two of the words presented were instruct and consult. By combining the first and second syllables of the two words in order, the word insult was formed. This word was used as a new or distractor word on the recognition test. The

test consisted of a series of two-alternative forced-choice items. Thus, on test, insult occurred as a new word, being paired with an old word but never one of the old words from which it was derived. On the test, in fact, insult was paired with reptile, an old word which, along with fervent, was used to produce the word fertile by merging fer and tile. It is important to understand the nature of these pairings because formal similarity between the two alternatives at the time of test was eliminated as a source of error. Had, for example, insult been paired with consult on the test, the interpretation would be ambiguous. The method also would seem to have eliminated semantic factors as a source of error in recognition decisions. Since the word insult had never occurred on the study, nor did any word which had a meaning similar to its meaning, there appears to be no reason why insult should have been chosen instead of reptile if the decision was based on semantic information. In short, if insult were chosen, the interpretation based on a frequency input to each syllable independently during study seems reasonably clean.

The experiment was designed to test three predictions. Two of these were positive in the sense that if syllabic frequency is a source of error, more errors would be expected to occur for experimental pairings than for control pairings. The third prediction was of a null outcome. Each of these three will be considered in order.

On the test, half of the pairs consisted of an old word and a merged or induced word (I word), whereas the other half consisted of an old word and a neutral new word (C word). The theory predicts more errors

for the former pairs than for the latter.

The second prediction has to do with testing effects. It is known that if a new word on a forced-choice test is used more than once (in two or more pairs), errors may increase with each successive use (Underwood & Freund, 1970). This suggests that frequency induced during testing will influence decisions on pairs occurring later in the test series. It seems quite possible, then, that syllabic frequency can be increased during testing. For example, if the words instruct and consult are tested prior to the testing of insult, more errors should result (the syllables of insult gain additional frequency) than if insult is tested prior to the testing of instruct and consult. Conditions were arranged to test this by having half the I words tested before their inducing words were tested, and half after their inducing words were tested.

It might be argued that words resulting from the merging of two syllables of other words have some special or unusual characteristic which make them good lures on a forced-choice test. To eliminate this possibility, the I words were used as new words on the test without the inducing words (e.g., consult and instruct) having occurred on the study list. If there is something peculiar about the I words, more errors should occur for these items than for the C words. The theory that syllabic frequency is induced during study (when appropriate words are used) would predict no difference between pairs containing I and C words under these circumstances.

Method

The three predictions can be tested by two groups of subjects, one being used for the first two predictions, the second for the third. However, in order to study the testing effects for all I words, two forms were required, hence there were four groups of subjects. The two involved in the first two predictions will be called the inducing groups, I-1 and I-2, those in the third, the control groups, C-1 and C-2. The description of the arrangement of the materials for these four groups essentially describes the conditions of the experiment.

Group I-1. The study list consisted of 48 two-syllable words varying in Thorndike-Lorge frequency between 1 and AA. Although the 48 words were presented singly, they may be thought of as 24 pairs of inducing study words in that from each pair a critical test word was derived (I word) by combining the first syllable of one of the words with the second syllable of the other. Only 5 of the 96 syllables occurred more than once and only three of these occurred as parts of the critical test words. Essentially, then, each I word would have one frequency input for each of the syllables. The 48 words were randomized in the study list subject only to the restriction that any two words used to produce an I word could not occupy adjacent positions in the list.

For the test list the 24 critical words were used as new words along with 24 additional neutral words (C words). These 24 neutral words were matched on first letters and Thorndike-Lorge frequencies

with the 24 I words. Of the 48 syllables represented by these 24 C words, only nine were represented among the 48 words used in the study list. The 48 new words were paired randomly with the 48 study words for the test with two restrictions. One I word and one C word were paired with the two words constituting an inducing pair, and an I word was never paired with one of the members of its inducing pair.

One restriction was applied to the ordering of the test pairs. In order to study testing effects, it was necessary to have pairs containing I words tested prior to the testing of the two study words from which each was derived, and the reverse order must also obtain. Twelve I words were chosen arbitrarily and placed in the first half of the test sequence, with their inducing items tested in the second half. The remaining I words occurred in pairs tested in the second half, with their inducing items being tested in the first half. Within each half the ordering was random.

Group I-2. For this group the procedure was exactly the same as for Group I-1. The only difference was that the test halves were reversed. Thus, by summing across the tests for Groups I-1 and I-2, each I word occurred in a pair in the first half of the test (not being preceded by tests of the two inducing items) and once in a pair in the second half (having been preceded by tests of the two inducing words).

Group C-1. The study list for this group was composed of 48 words matched on first letters and on Thorndike-Lorge frequencies with the 48 study words shown to Groups I-1 and I-2. These were chosen to have minimum duplication of syllables with the critical test items. Of the 96 syllables, eight matched a syllable in the I words, but in no case were both syllables of an I word represented by syllables of the study

words. The test series was exactly the same as for Group I-1 except that the neutral study words replaced the 48 inducing study words of Group I-1.

Group C-2. This group had exactly the same materials as Group C-1. The only difference was the reversal of the test halves.

Procedure and subjects. The study lists were presented once at a 1-second rate. The subjects were told that they would be given a recognition test but its nature was not specified. Immediately after the presentation of the last word, instructions were given for the forced-choice recognition test. The subjects were informed that each pair contained a word shown to them during study and one which had not been shown, and they were to call out the correct word. Each pair was presented for 3 seconds and the subject was told that he must choose one of the words within this interval, guessing if necessary. The right-left positions of the correct words in the pairs were determined randomly.

Thirty college students were assigned to each of the four groups by a block-randomized schedule. It should be noted again that Groups I-1 and I-2 were used only to allow each I word to occur once in the first half of the test series, and once in the second half, so that any testing effects which occurred would be measured for pairs containing all 24 I words. The same is true for Groups C-1 and C-2, although there was no reason to anticipate unusual testing effects for these groups since neutral items were used in both study and test as correct items.

Results

I Groups. The results for the I Groups will be examined first. On the test for these groups there were 12 pairs containing I words on the first half of the test, and also 12 pairs containing neutral or C words. The same was true for the second half. The numbers of errors for each class of items for each half were determined. These were combined for Groups I-1 and I-2 and presented as percentages in the left panel of Fig. 1. The number of errors was greater for the pairs containing I words than for the pairs containing C words in both halves as would be anticipated if frequency information about the syllables is a part of the memory for a word. For both types of items the errors increased from the first half to the second half, but the increase was greater for the I words.

The statistical analysis supports the differences seen in the figure. The difference between the I and C words was reliable ($F=43.53$) as was test halves ($F=19.61$). In addition, the interaction between item type and test halves was significant, $F(1,174)=5.68$, $p<.05$. Of the 60 subjects, 45 made more errors on I words than on C words during the first half of the test. The corresponding number for the second half was 56. The difference between the I and C pairs on the first half was also reliable, t $(58)=3.39$, $p<.01$. This, taken in conjunction with the interaction between item type and halves, suggested (according to theory) that syllabic frequency was induced during the study phase and further incremented during the test phase.

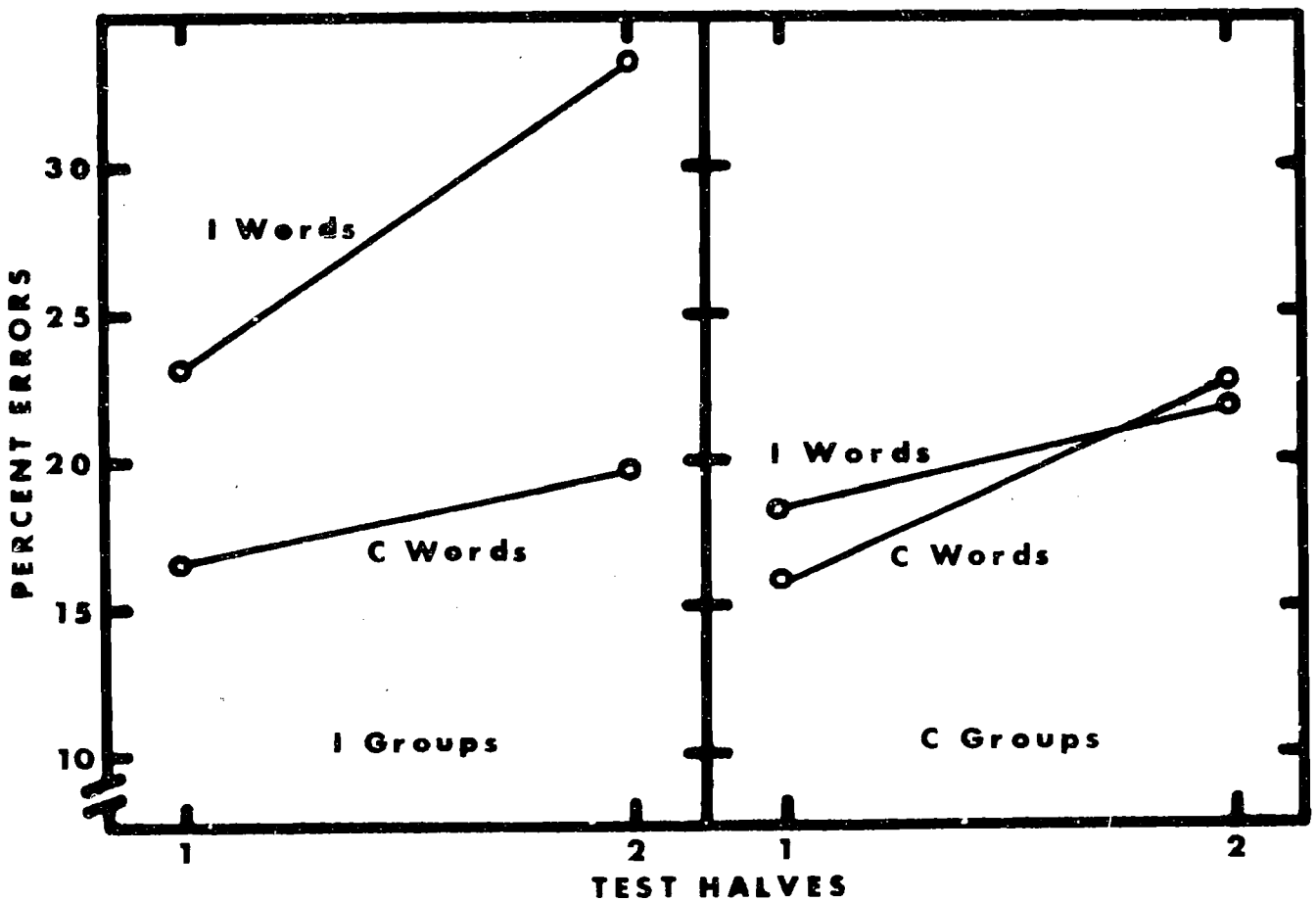

Fig. 1. Recognition errors for I and C items when appropriate inducing words were used in the study list (I Groups) and when inappropriate words were used (C Groups).

Finally, the statistical tests showed a substantial interaction (F=10.01) between word type and Groups (the I-C difference was greater for Group I-2 than for Group I-1). This was produced by there being fewer errors for the C words for Group I-2 than for Group I-1. Errors on the I words were essentially equivalent for both groups. It is not known why the C words should differ in difficulty for the two groups. However, the interaction between Groups and test halves was not reliable (F=1.84), nor was the triple interaction ($F < 1$).

Groups C-1 and C-2. It will be remembered that the test for these groups included the critical test items (I words), but the study list consisted of neutral words in that the syllable overlap between them and the I words was minimal. Theoretically, therefore, the prediction was of a null result for the I-C difference. The right-hand panel of Fig. 1 shows the outcome. The only significant source of variance was test halves (F=17.44). It should be noted that the slopes of the two curves correspond quite closely to the slope of the curve for the C items for Groups I-1 and I-2. That there is a positive slope indicates that there are other unidentified sources of testing effects; perhaps forgetting increases as the retention interval gets longer during testing, or there might be other factors involved.

Discussion

The results were consonant with three expectations from frequency theory. A word on the test consisting of two syllables, each having

appeared in a different word on the study list, "drew" more errors than did a control word. Based upon the assumption that when the two syllables each gain a unit of frequency, the word as a unit possesses some level of frequency greater than the control word, the results would be anticipated. Frequency theory, as thus far developed, does not specify the composition rules whereby the phenomenal frequency of a larger unit can be predicted knowing the input frequency on subunits. Therefore, the present study has proceeded on the assumption that the apparent frequency of the larger unit would be greater than that of a control unit; how much greater is not known. The prediction that the syllable frequency would be further incremented during testing was also supported. Finally, it was shown that the first two findings were not due to a peculiarity of the critical words per se, since omitting the words used to induce syllable frequency during study had no influence on recognition errors produced by the critical words.

The positive effects observed, while highly reliable statistically, were not large in an absolute sense. Certainly the effect was much less than would be expected had the critical word been presented during study. There are many possibilities as to why this outcome might be expected. For example, a syllable may not gain frequency unless pronounced, implicitly or explicity. However, the present study does not elucidate such mechanisms.

Alternative explanations must be considered. It seems that the choice of the I word, thereby producing an error, was not based on its semantic

characteristics. The word had not occurred during study and words with similar meanings were not presented during study. The I word was a composite of the two parts of two words, each having different meaning, and neither of which was similar to the meaning of the I word. In one way of viewing the procedures they are in correspondence to those used in a study of recognition memory for sentences by Bransford and Franks (1971). If parts of complex sentences were presented for study, parts which in themselves constituted sentences, the subject had a high probability of identifying the complex sentence as one which had been presented when in fact it had not. An interpretation in terms of synthesis of meaning may be appropriate for that effect but it clearly will not fit the present results. On the other hand, it is not beyond possibility that the Bransford-Franks finding may yield to a frequency interpretation. The work of Reitman and Bower (1973) makes such an interpretation plausible.

The present results might be interpreted in terms of formal similarity. That is, the I word was necessarily formally similar to words presented for study. Two remarks seem appropriate. First, the formal similarity did not obtain at the time of the test in that the two words in each test pair were not formally similar. Thus, there could not have been a perceptual discrimination failure at the time of the test. Second, it might be argued that when the subject was in doubt about the correct word in a pair he made his decision by saying, in effect, "there was a word or two like this in the list." However, formal

similarity is an independent variable and how it influences behavior requires interpretation. It is our belief that formal similarity influences recognition performance (when it does) because of the induced frequency of the components or elements of the larger units. With poorly integrated units, such as consonant syllables, the individual letters or bigrams may be the critical elements in the frequency accrual and by which formal similarity produces its effect. With words, we have assumed that the syllable is a "natural" element which could have frequency representation independent of the frequency of the larger unit. In short, the effects of formal similarity may be interpreted by referring to frequency inputs on elements of larger units.

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